

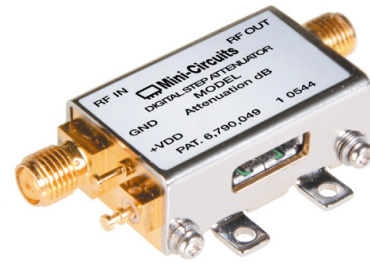
Digital Step Attenuator

50 Ω DC-2400 MHz

31 dB, 1 dB Step, 5 Bit, Parallel Control Interface,
Single Supply Voltage

Product Features

- Low Insertion Loss
- High IP3, +52 dBm Typ
- Excellent return loss, 20 dB Typ
- Excellent accuracy, 0.1 dB Typ
- Single Supply Voltage: +3V
- Control inputs buffered by Schmitt Triggers
- Rigid unibody case
- Protected by US patent 6,790,049



ZX76-31-PP-S+

Typical Applications

- Lab
- Instrumentation
- Test equipment

Connectors	Order P/N
SMA	ZX76-31-PP-S+

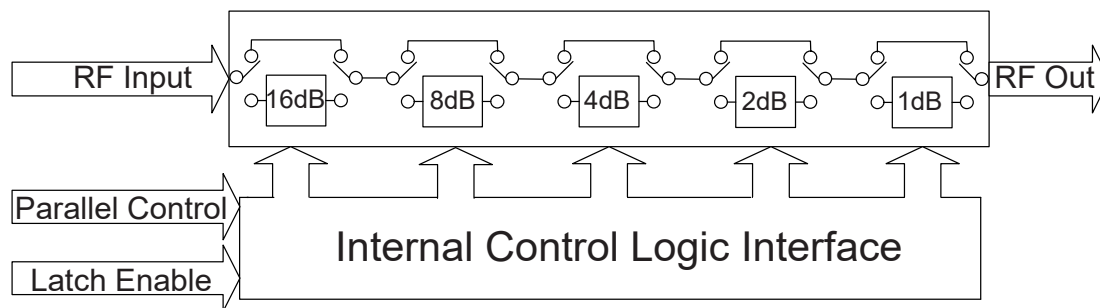
+RoHS Compliant

The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

General Description

The ZX76-31-PP-S+ is a 50 Ω RF digital step attenuator that offers an attenuation range up to 31 dB in 1.0 dB steps. The control is a 5-bit parallel interface. The model operates on a single +3 volt supply. See application note AN-70-004 for 5V supply voltage. The ZX76-31-PP-S+ is produced using a unique case package for ruggedness and operation in tough environments.

Simplified Schematic



RF Electrical Specifications, DC-2400 MHz, $T_{AMB}=25^{\circ}\text{C}$, $V_{DD}=+3\text{V}$

Parameter	Freq. Range (GHz)	Min.	Typ.	Max.	Units
Accuracy @ 1 dB Attenuation Setting	DC-1	—	0.02	0.1	dB
	1-2.4	—	0.05	0.15	dB
Accuracy @ 2 dB Attenuation Setting	DC-1	—	0.05	0.15	dB
	1-2.4	—	0.15	0.25	dB
Accuracy @ 4 dB Attenuation Setting	DC-1	—	0.07	0.2	dB
	1-2.4	—	0.15	0.25	dB
Accuracy @ 8 dB Attenuation Setting	DC-1	—	0.03	0.2	dB
	1-2.4	—	0.15	0.3	dB
Accuracy @ 16 dB Attenuation Setting	DC-1	—	0.1	0.3	dB
	1-2.4	—	0.2	0.5	dB
Insertion Loss @ all attenuator set to 0dB	DC-1	—	1.5	2.2	dB
	1-2.4	—	2.0	3.0	dB
IP3 Input* (at Min. and Max. Attenuation)	DC-2.4	—	+52	—	dBm
Input Power @ 0.2dB Compression* (at Min. and Max. Attenuation)	DC-2.4	—	+24	—	dBm
VSWR	DC-1	—	1.2	1.5	—
	1-2.4	—	1.2	1.5	—

* IP3 and 1dB compression degrade below 1 MHz

DC Electrical Specifications

Parameter	Min.	Typ.	Max.	Units
V_{DD} , Supply Voltage	2.7	3	3.3	V
I_{DD} , Supply Current	—	—	3	mA
Control Input Voltage Low	0	—	$0.3 \times V_{DD}$	V
Control Input Voltage High	$0.7 \times V_{DD}$	—	5V	V
Control Current	—	—	400	μA

Switching Specifications

Parameter	Min.	Typ.	Max.	Units
Switching Speed, 50% Control to 0.5dB of Attenuation Value	—	1.0	—	μSec
Switching Control Frequency	—	—	25	KHz

Absolute Maximum Ratings

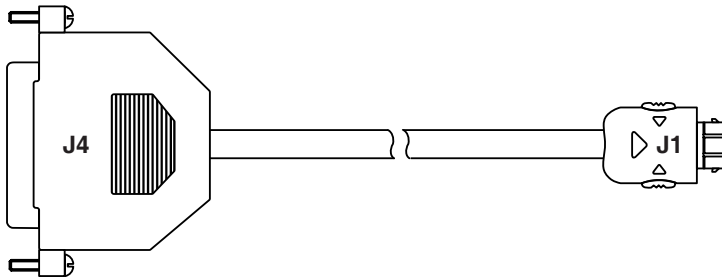
Parameter	Ratings
Operating Temperature	-40°C to 85°C
Storage Temperature	-40°C to 85°C
V_{DD} , Supply Voltage	-0.3V Min., 4V Max.
Voltage on Control Input	-0.3V Min., 6V Max.
ESD, HBM	500V
ESD, MM	100V
Input Power	+24dBm

Permanent damage may occur if any of these limits are exceeded

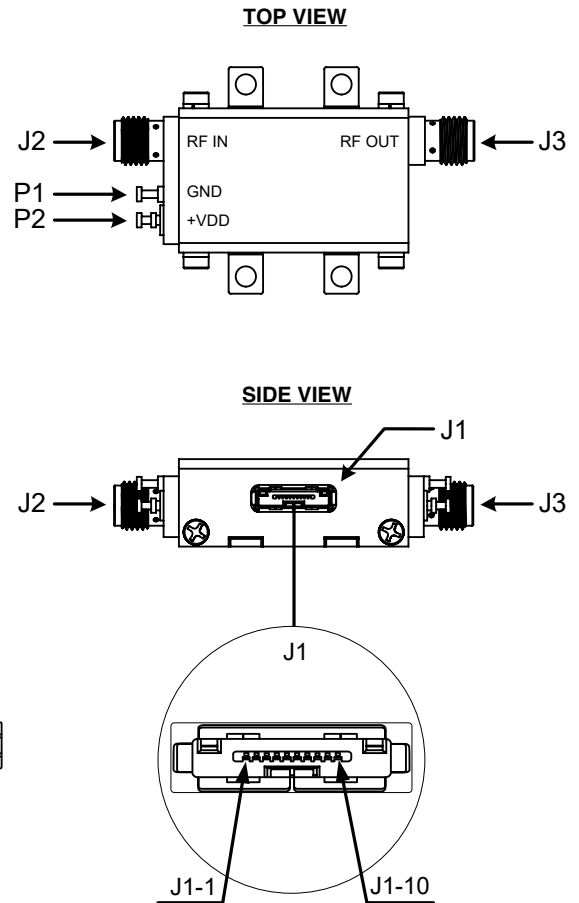
Pin Description

Function	Pin Number	Description
LE	J1-1	Latch Enable Input
C1	J1-2	Control for attenuation bit, 1 dB
-	J1-3	Not used
N/C	J1-4	Not Connected
C16	J1-5	Control for attenuation bit, 16 dB
GND	J1-6	Ground connection
GND	J1-7	Ground connection
C4	J1-8	Control for attenuation bit, 4 dB
C8	J1-9	Control for attenuation bit, 8 dB
C2	J1-10	Control for attenuation bit, 2 dB
RF in	J2	RF in port (Note 1)
RF out	J3	RF out port (Note 1)
GND	P1	Ground connection
VDD	P2	Positive Supply Voltage

Note 1: Both RF ports must be held at 0VDC or DC blocked with an external series capacitor.



Pin Configuration



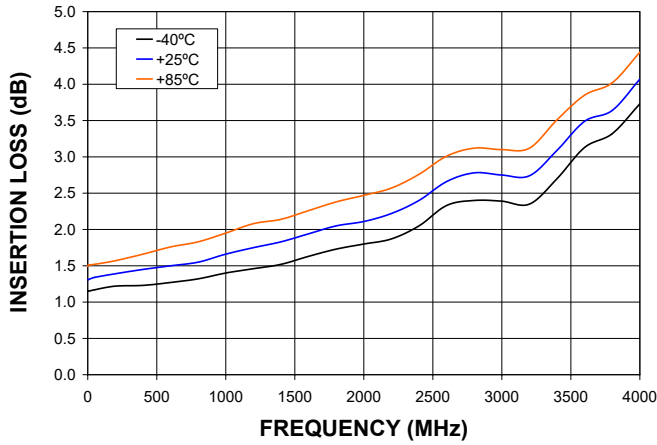
Cable Pin Description

J1-Pin Number	J4-Pin Number	Function	Description	Wire Color
J1-1	J4-8	LE	Latch Enable Input	WHITE
J1-2	J4-3	C1	Control for attenuation bit, 1 dB	YELLOW
J1-3	J4-2	-	Not used	GREEN
J1-5	J4-7	C16	Control for attenuation bit, 16 dB	BLUE
J1-6	J4-20	GND	Ground connection	BLACK
J1-8	J4-5	C4	Control for attenuation bit, 4 dB	ORANGE
J1-9	J4-6	C8	Control for attenuation bit, 8 dB	BROWN
J1-10	J4-4	C2	Control for attenuation bit, 2 dB	RED

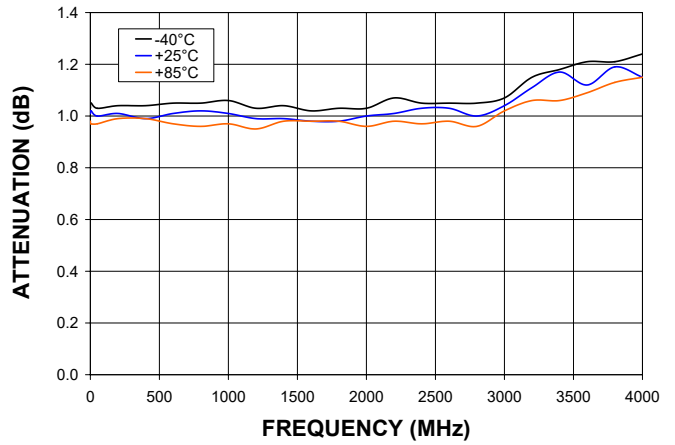
Note: Other pins not connected. Cable shield connected to case ground.

Typical Performance Curves

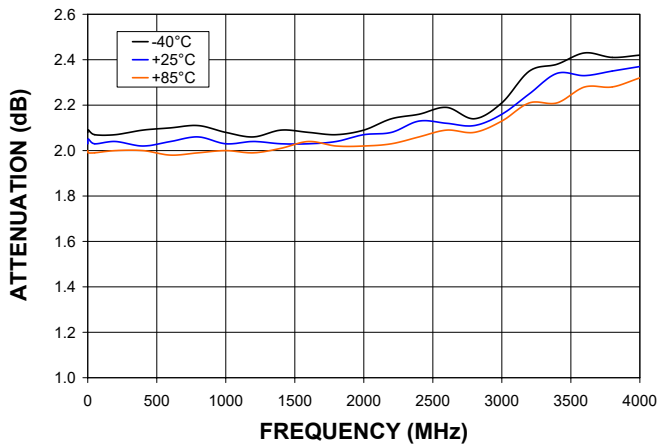
INSERTION LOSS (Ref)



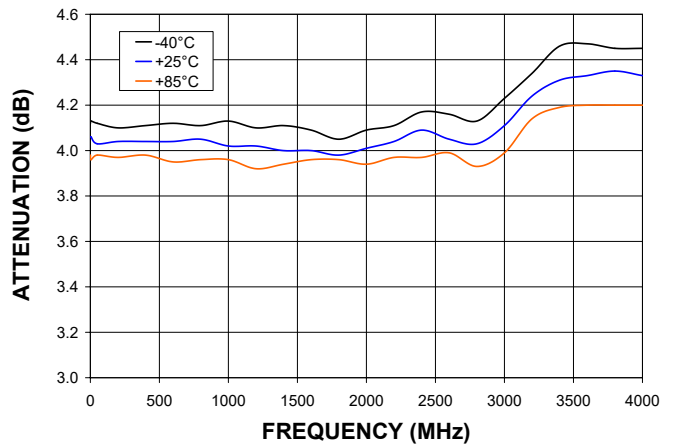
ATTENUATION (1 dB)



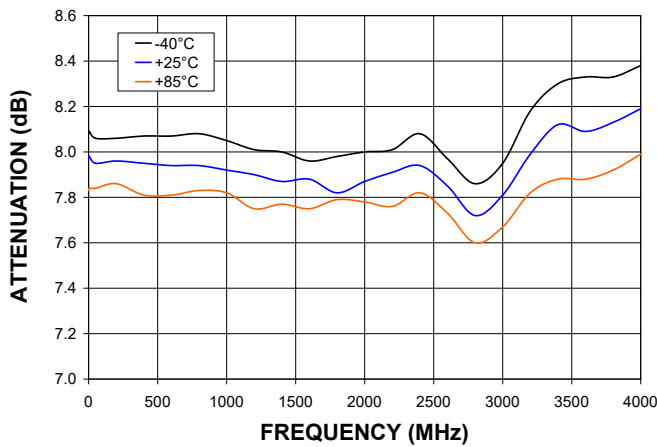
ATTENUATION (2 dB)



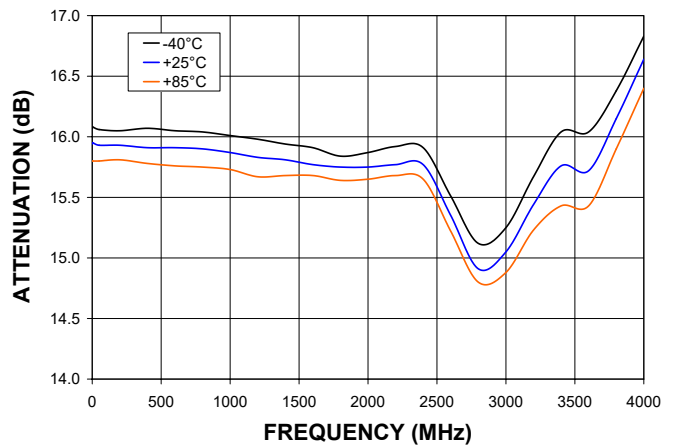
ATTENUATION (4 dB)



ATTENUATION (8 dB)

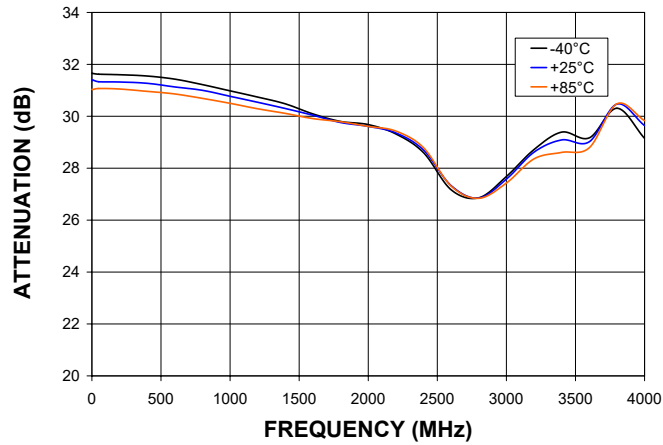


ATTENUATION (16 dB)

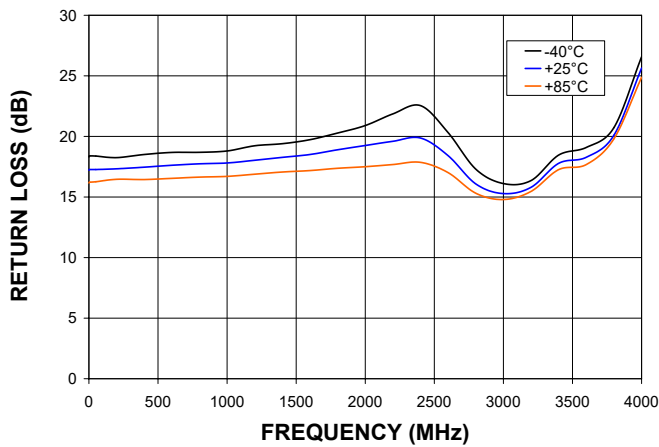


Typical Performance Curves

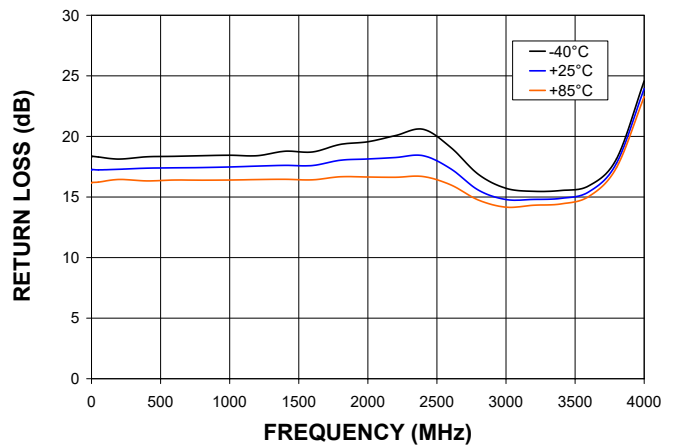
ATTENUATION (31 dB)



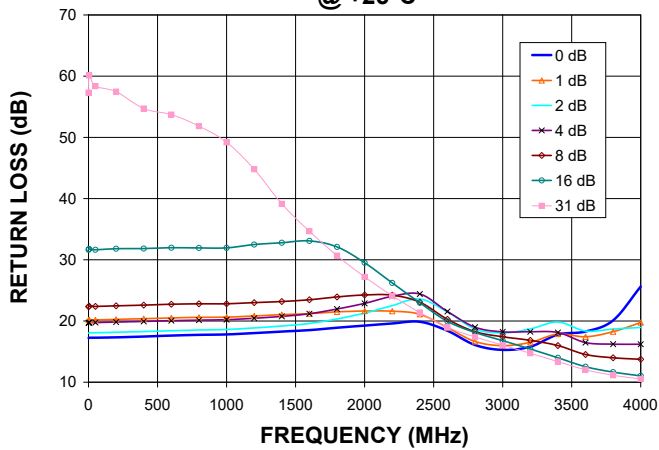
RETURN LOSS IN (Ref)



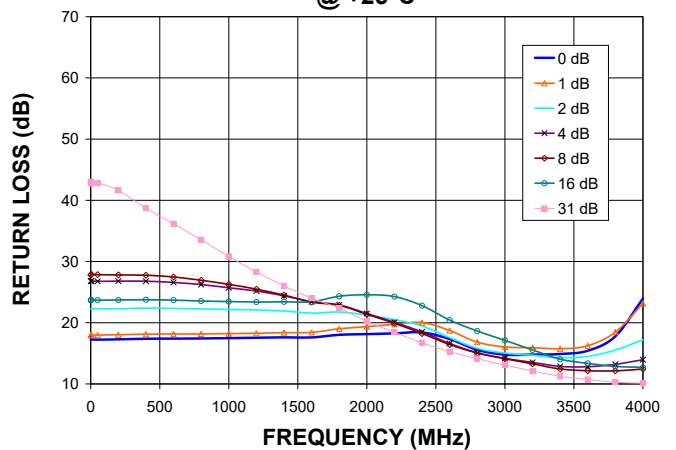
RETURN LOSS OUT (Ref)



RETURN LOSS IN (Major Atten. Steps)
@ +25°C



RETURN LOSS OUT (Major Atten. Steps)
@ +25°C



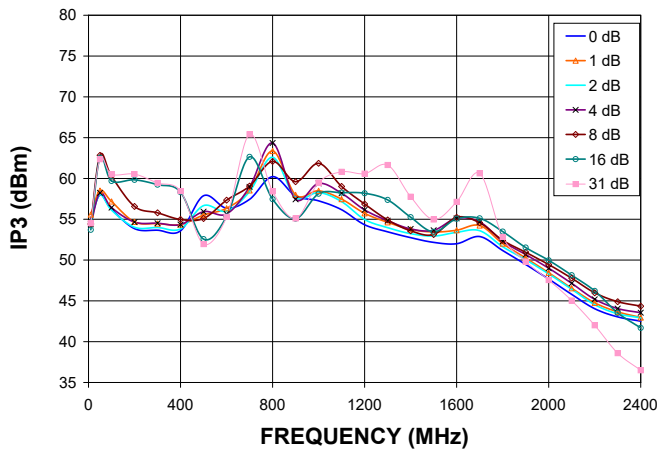
NON-CATALOG

Digital Step Attenuator

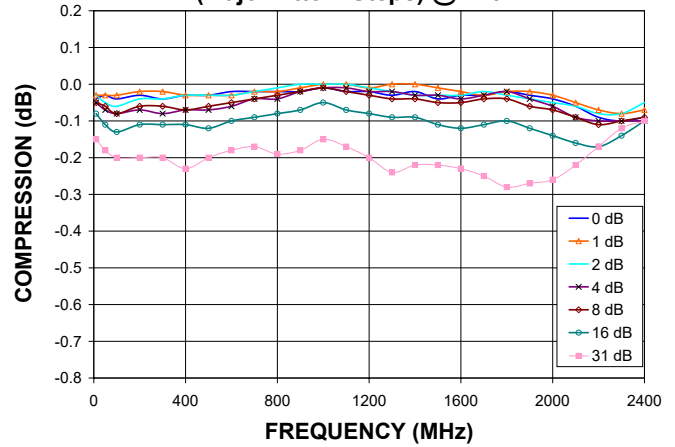
ZX76-31-PP-S+

Typical Performance Curves

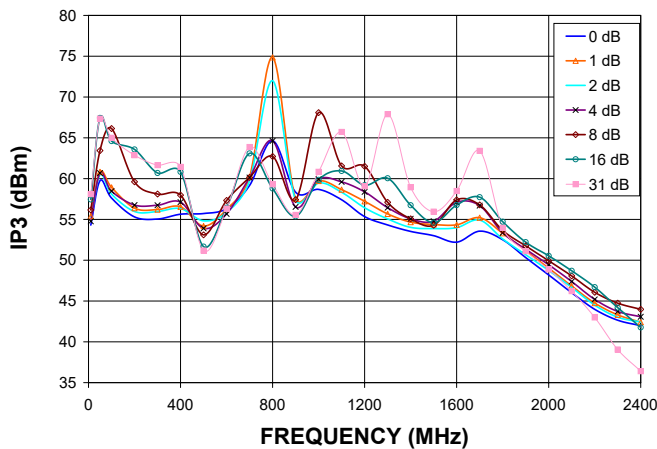
IP3 (Major Atten. Steps) @ +25°C



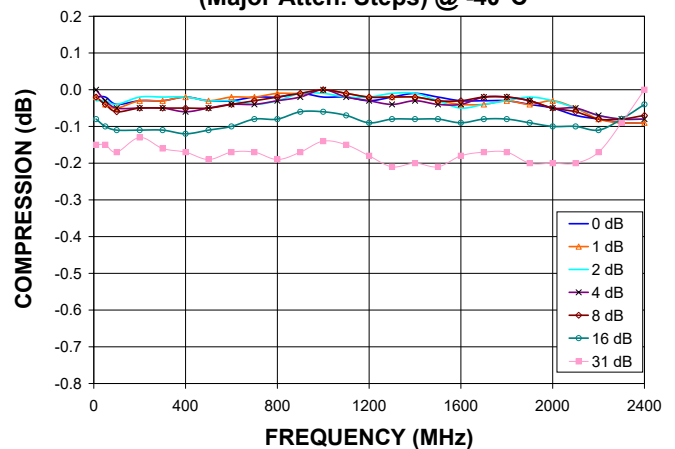
COMPRESSION @ INPUT POWER=+24dBm
(Major Atten. Steps) @ +25°C



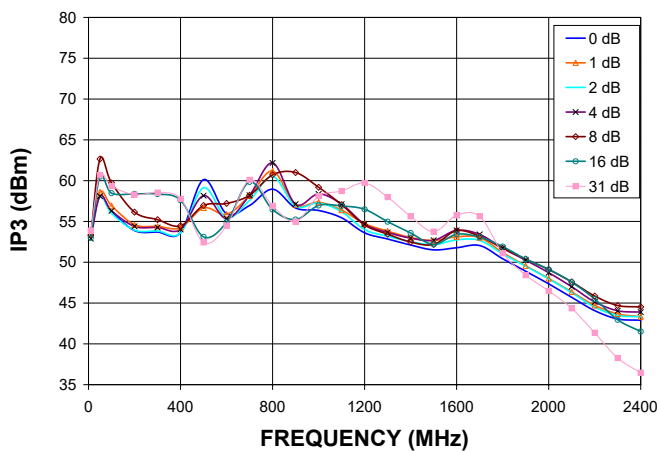
IP3 (Major Atten. Steps) @ -40°C



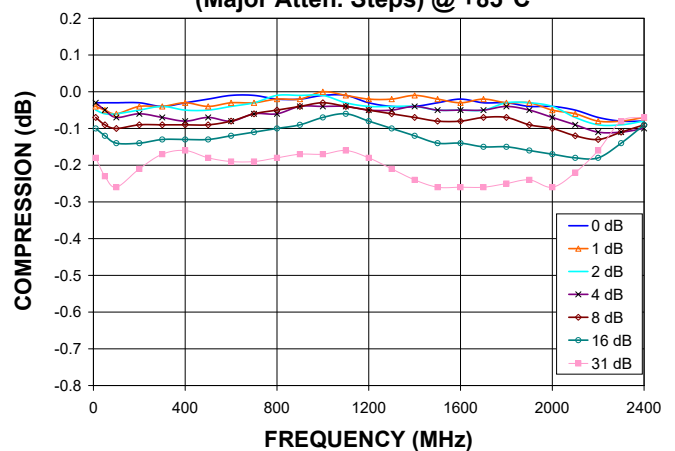
COMPRESSION @ INPUT POWER=+24dBm
(Major Atten. Steps) @ -40°C



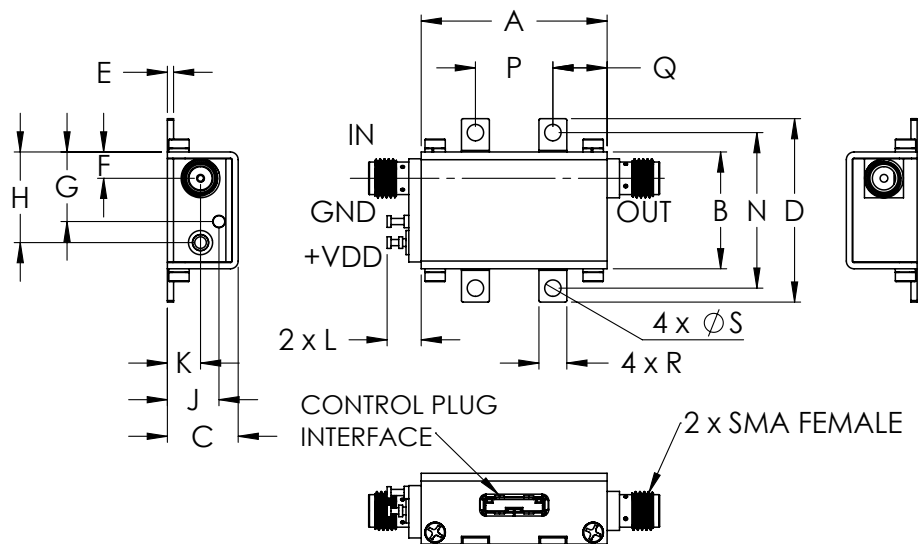
IP3 (Major Atten. Steps) @ +85°C



COMPRESSION @ INPUT POWER=+24dBm
(Major Atten. Steps) @ +85°C



Outline Drawing



NOTE: When soldering the DC connections, caution must be used to avoid overheating the DC terminals. See Application Note [AN-40-10](#).

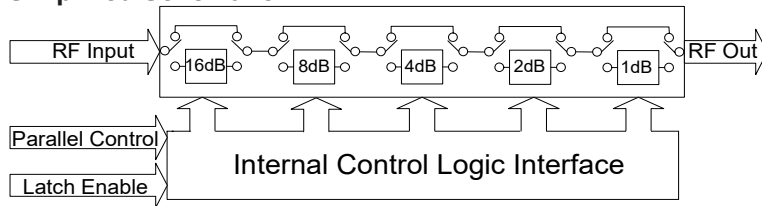
Outline Dimensions (inch mm)

A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	WT. GRAMS
1.20	.75	.46	1.18	.04	.17	.45	.59	.33	.21	.22	-	1.00	.50	.35	.18	.106	35
30.48	19.15	11.61	30.07	1.02	4.32	11.40	14.86	8.31	5.44	5.59	-	25.40	12.70	8.89	4.57	2.69	

Recommended Mounting Hardware:

Use UNC#2 pan head screws with internal tooth lock washers for unit mounting.

Simplified Schematic



The ZX76-31-PP-S+ parallel interface consists of 5 control bits that select the desired attenuation state, as shown in Table 1: Truth Table

Table 1. Truth Table					
Attenuation State	C16	C8	C4	C2	C1
Reference	0	0	0	0	0
1 (dB)	0	0	0	0	1
2 (dB)	0	0	0	1	0
4 (dB)	0	0	1	0	0
8 (dB)	0	1	0	0	0
16 (dB)	1	0	0	0	0
31 (dB)	1	1	1	1	1

Note: Not all 32 possible combinations of C1 - C16 are shown in table

The parallel interface timing requirements are defined by Figure 1 (Parallel Interface Timing Diagram) and Table 2 (Parallel Interface AC Characteristics), and switching speed.

For latched parallel programming the Latch Enable (LE) should be held LOW while changing attenuation state control values, then pulse LE HIGH to LOW (per Figure 1) to latch new attenuation state into device.

For direct parallel programming, the Latch Enable (LE) line should be pulled HIGH. Changing attenuation state control values will change device state to new attenuation. Direct mode is ideal for manual control of the device (using hardwire, switches, or jumpers).

Control cables for programming can be ordered separately. For details see page 9.

Figure 1: Parallel Interface Timing Diagram

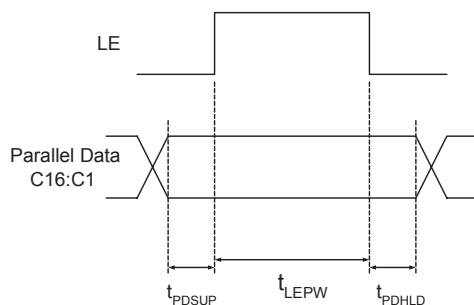


Table 2. Parallel Interface AC Characteristics			
Symbol	Parameter	Min.	Units
t_{LEPW}	LE minimum pulse width	10	ns
t_{PDSUP}	Data set-up time before clock rising edge of LE	10	ns
t_{PDHL}	Data hold time after clock falling edge of LE	10	ns

Power-up State

When the attenuator powers up and LE is logic low, the nominal attenuation is set on 0 dB. When LE is logic high, the nominal attenuation selected upon control logics (see Table 1).

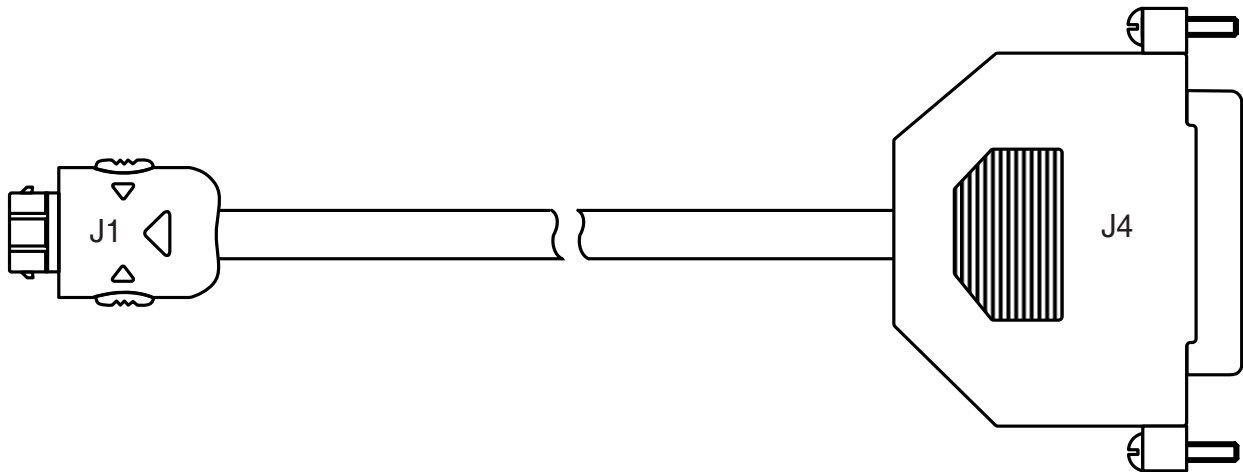
Recommended Accessories

Two optional cable accessories with and without interface connector are available with ZX76-31-PP-S+, the ZX76-CP+ and ZX76-WP+. Cable length is 4.9 feet / 1.5 meters.

ZX76-CP+ shielded cable with interface 25 pin D-type connector J4 and supplied software are used to control the ZX76-31-PP-S+ digital attenuator from a computer, using LPT port.

ZX76-WP+ shielded cable without interface 25 pin D-type connector enables customer to use the ZX76-31-PP-S+ digital attenuator in his own application.

ZX76-CP+ Control Cable



ZX76-CP+ wiring information

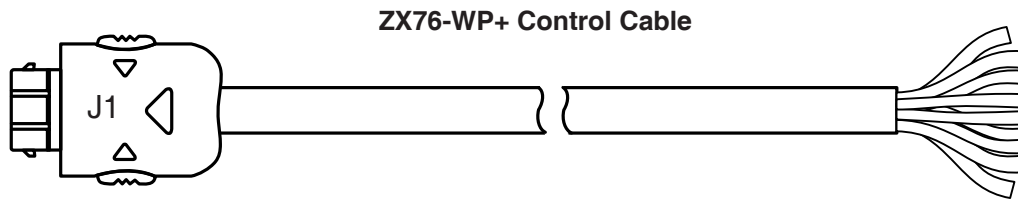
J1-Pin Number	J4-Pin Number	Function	Description	Wire Color
J1-1	J4-8	LE	Latch Enable Input	WHITE
J1-2	J4-3	C1	Control for attenuation bit, 1 dB	YELLOW
J1-3	J4-2	-	Not used	GREEN
J1-5	J4-7	C16	Control for attenuation bit, 16 dB	BLUE
J1-6	J4-20	GND	Ground connection	BLACK
J1-8	J4-5	C4	Control for attenuation bit, 4 dB	ORANGE
J1-9	J4-6	C8	Control for attenuation bit, 8 dB	BROWN
J1-10	J4-4	C2	Control for attenuation bit, 2 dB	RED

Note: Other pins not connected. Cable shield connected to case ground.

NON-CATALOG

Digital Step Attenuator

ZX76-31-PP-S+



ZX76-WP+ wiring information

Pin Number	Function	Description	Wire Color
J1-1	LE	Latch Enable Input	WHITE
J1-2	C1	Control for attenuation bit, 1 dB	YELLOW
J1-3	-	Not used	GREEN
J1-5	C16	Control for attenuation bit, 16 dB	BLUE
J1-6	GND	Ground connection	BLACK
J1-8	C4	Control for attenuation bit, 4 dB	ORANGE
J1-9	C8	Control for attenuation bit, 8 dB	BROWN
J1-10	C2	Control for attenuation bit, 2 dB	RED

Note: Other pins not connected. Cable shield connected to case ground.

Ordering Information

Model Number	Description
ZX76-31-PP-S+	Digital attenuator - Parallel interface Single Positive Supply Voltage
ZX76-CP+	Cable accessory with interface connector
ZX76-WP+	Cable accessory without interface connector

Additional Notes

- Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
- Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at www.minicircuits.com/MCLStore/terms.jsp



Digital Step Attenuator

ZX76-31-PP+

Typical Performance Data

FREQUENCY (MHz)	STEP ATTENUATION* AT TTL CONTROL STATE						
	(dB)						
	00000 THRU LOSS	00001 1 dB	00010 2 dB	00100 4 dB	01000 8 dB	10000 16 dB	11111 31 dB
10	1.36	1.00	2.02	4.03	7.92	15.89	30.73
50	1.37	1.00	2.02	4.03	7.93	15.87	30.76
100	1.38	1.01	2.03	4.03	7.93	15.89	30.72
200	1.39	1.01	2.04	4.03	7.93	15.88	30.74
500	1.49	1.01	2.03	4.02	7.91	15.85	30.60
800	1.55	1.00	2.04	4.03	7.93	15.85	30.44
1000	1.59	1.01	2.08	4.06	7.95	15.83	30.36
1200	1.72	1.00	2.04	4.00	7.89	15.80	30.09
1400	1.84	1.00	2.01	3.96	7.83	15.72	29.83
1600	1.82	1.01	2.07	4.02	7.90	15.77	29.73
1800	1.91	1.00	2.06	4.02	7.88	15.78	29.50
2000	2.02	1.02	2.06	4.03	7.87	15.74	29.25
2200	2.25	1.00	2.07	4.03	7.88	15.66	28.97
2400	2.41	1.00	2.04	3.98	7.81	15.62	28.41
2600	2.38	1.05	2.12	4.04	7.88	15.68	28.31
3000	2.94	1.04	2.15	4.10	7.91	15.58	28.16

* Step Attenuation above Thru Loss (TTL Logic 00000).

FREQUENCY (MHz)	INPUT RETURN LOSS AT TTL CONTROL STATE						
	(dB)						
	00000 0 dB	00001 1 dB	00010 2 dB	00100 4 dB	01000 8 dB	10000 16 dB	11111 31 dB
10	17.10	20.08	17.99	19.66	22.37	32.02	43.63
50	17.14	20.14	18.03	19.72	22.43	32.16	43.88
100	17.15	20.13	18.05	19.73	22.39	31.99	43.09
200	17.23	20.20	18.11	19.77	22.44	32.02	43.10
500	17.58	20.55	18.44	20.10	22.77	32.58	43.97
800	17.94	20.93	18.81	20.47	23.17	33.46	43.93
1000	18.13	21.13	19.07	20.79	23.56	34.67	42.26
1200	18.41	21.43	19.51	21.24	24.06	36.01	38.55
1400	18.65	21.64	19.96	21.77	24.63	37.01	34.99
1600	18.84	21.77	20.49	22.43	25.29	35.91	31.74
1800	19.04	21.90	21.20	23.32	26.03	32.71	28.73
2000	19.12	21.81	21.93	24.23	26.42	29.17	26.07
2200	19.19	21.70	22.78	25.23	26.46	26.24	23.80
2400	19.80	22.30	24.53	27.00	26.28	23.66	21.72
2600	21.50	23.56	28.00	28.57	24.66	21.11	19.70
3000	22.65	22.45	26.32	23.43	20.26	17.28	16.48

FREQUENCY (MHz)	OUTPUT RETURN LOSS AT TTL CONTROL STATE						
	(dB)						
	00000 0 dB	00001 1 dB	00010 2 dB	00100 4 dB	01000 8 dB	10000 16 dB	11111 31 dB
10	17.08	17.84	22.31	26.97	27.98	23.56	39.26
50	17.11	17.88	22.35	27.02	28.04	23.60	39.03
100	17.15	17.91	22.36	26.99	27.99	23.56	39.10
200	17.22	17.96	22.43	27.04	27.97	23.58	38.39
500	17.47	18.23	22.70	27.12	27.91	23.75	34.61
800	17.72	18.48	22.86	26.86	27.41	23.90	31.22
1000	18.18	18.97	23.47	27.29	27.70	24.70	29.02
1200	18.22	19.10	23.31	26.34	26.63	24.95	26.80
1400	18.37	19.32	23.23	25.46	25.69	25.55	24.90
1600	18.41	19.56	22.92	24.32	24.52	26.23	23.14
1800	18.49	19.83	22.58	23.24	23.38	27.13	21.59
2000	18.55	20.14	22.01	21.93	22.04	27.66	20.00
2200	18.48	20.29	21.15	20.60	20.64	26.95	18.63
2400	18.22	20.19	20.59	19.60	19.65	25.84	17.78
2600	19.33	22.03	21.85	20.57	20.28	27.42	17.49
3000	20.89	22.42	18.95	16.77	16.25	18.78	14.23

REV. X1
ZX76-31-PP+
061211
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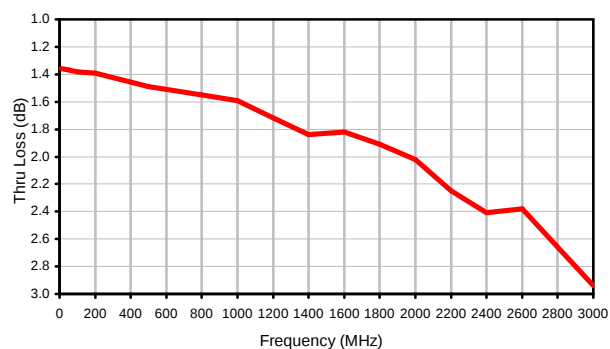


Digital Step Attenuator

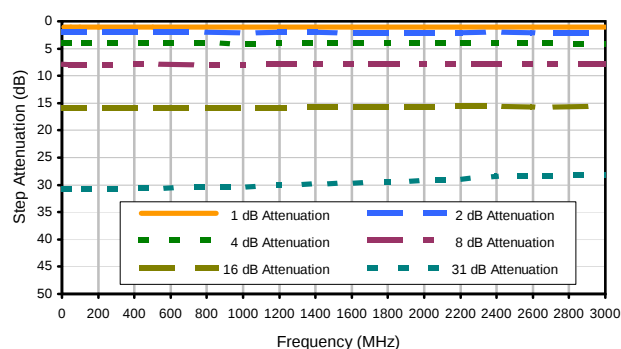
Typical Performance Curves

ZX76-31-PP+

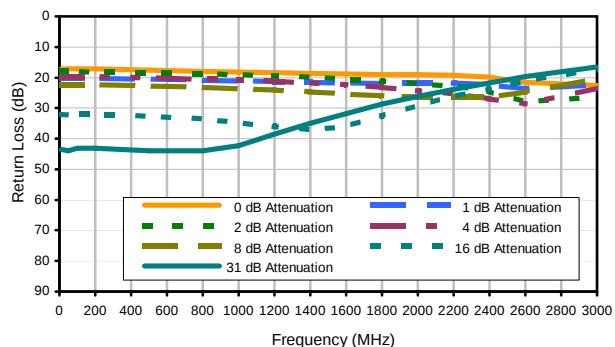
Thru Loss



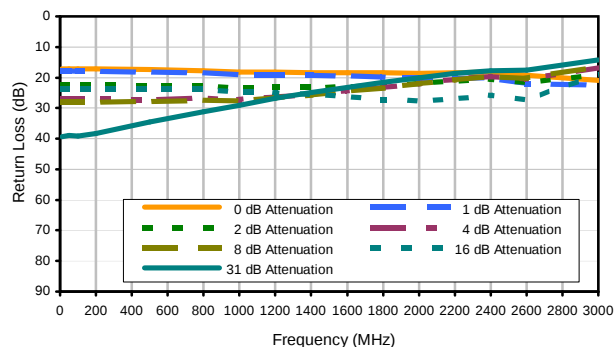
Step Attenuation



Input Return Loss



Output Return Loss



REV. X1
ZX76-31-PP+
061211
Page 1 of 1



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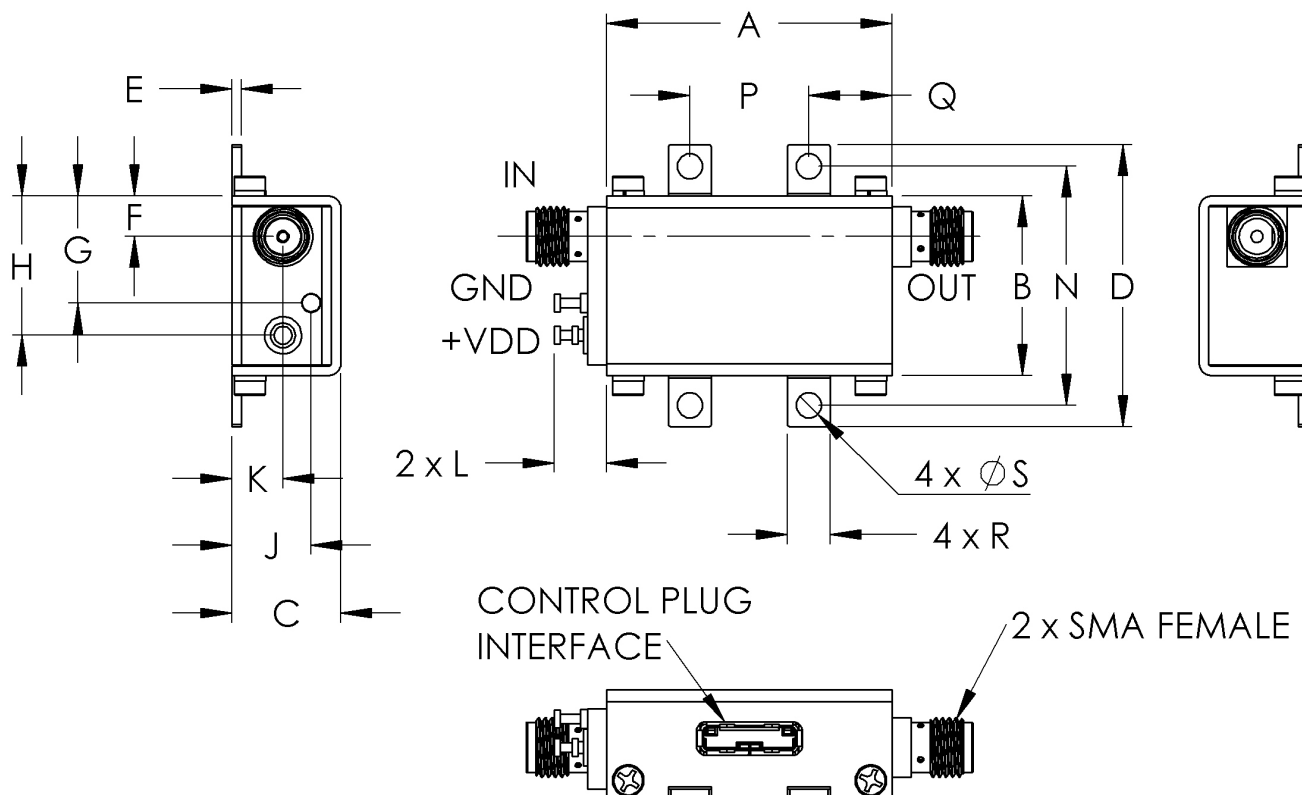


Case Style

HK

Outline Dimensions

HK1172



CASE #.	A	B	C	D	E	F	G	H	J	K	L	M	N
HK1172	1.20 (30.48)	.75 (19.15)	.46 (11.61)	1.18 (30.07)	.04 (1.02)	.17 (4.32)	.45 (11.40)	.59 (14.86)	.33 (8.31)	.21 (5.44)	.22 (5.59)	-	1.00 (25.4)

CASE #.	P	Q	R	S	WT GRAMS
HK1172	.50 (12.70)	.35 (8.89)	.18 (4.57)	.106 (2.69)	35

Dimensions are in inches (mm). Tolerances: 2Pl. $\pm .03$; 3Pl. $\pm .015$

Tolerance on hole size and interaxes dimensions to be $\pm .005$.

Note:

1. Case material: Brass
2. Case finish: Nickel plate



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Mini-Circuits ISO 9001 & ISO 14001 Certified



All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-40° to 85° C Ambient Environment	Individual Model Data Sheet
Storage Temperature	-40° to 85° C Ambient Environment	Individual Model Data Sheet
Barometric Pressure	100,000 Feet	MIL-STD-202, Method 105, Condition D
Humidity	90% RH, 65°C Units may require bake-out after humidity to restore full performance.	MIL-STD-202, Method 103
Thermal Shock	-65° to 125°C, 5 cycles	MIL-STD-202, Method 107, Condition B
Vibration (High Frequency)	20g peak, 10-2000 Hz, 12 times in each of three perpendicular directions (total 36)	MIL-STD-202, Method 204, Condition D
Mechanical Shock	100g, 6ms sawtooth, 3 shocks each direction 3 axes (total 18)	MIL-STD-202, Method 213, Condition I